^{241}Am-^{9}Be Source for Neutron and γ-Ray Calibrations of SNO

E.B. Norman, C.E. Okada, Y.D. Chan, K.T. Lesko, A.D. Marino, Y.P. Opachich, A.W. Poon, A. Smith, R.G. Stokstad and J. Trigg for the SNO Collaboration

An AmBe source produces neutrons via the ^{9}Be(α,n)^{12}C reaction, with the α particles coming from the decay of ^{241}Am. The reaction has a Q-value of +5.701 MeV. Sixty per cent of these neutrons are emitted in coincidence with 4.44-MeV γ-rays resulting from the 1st excited 2^+ state in ^{12}C. When deployed in SNO, the 4.44 MeV γ-ray will produce a prompt Cerenkov event that usually will be followed, some milliseconds later, by a second Cerenkov event caused by the capture of the neutron on ^{35}Cl. Thus, this device provides a tagged source for determining the neutron lifetime and neutron detection efficiency in SNO. In addition, the 4.44- MeV γ-ray provides a new point that will aid in determining SNOs energy calibration.

The source has been designed and fabricated at LBNL and deployed into the SNO detector during salt-phase running (see Figure 1). A typical run takes about 2 hours. The SNO source manipulator system can position the source in two perpendicular planes inside the D_2O volume. In order to study the peakshape of the 4.44-MeV γ-ray the hardware threshold had been lowered beyond the standard data taking values. Non-physical instrumentation events were removed with data-cleaning cuts and the spatial vertices were reconstructed prior to data analysis. Figure 2 top panel shows the raw time separation spectrum between a neutron candidate event and a preceding event. After background subtraction, it was found that the time constant was consistent with the expected neutron capture time in salt. The middle panel shows a raw PMT hits spectrum for the source at the center of the detector without any coincidence and vertex reconstruction requirements. The bottom plot shows a cleaned AmBe neutron nhits spectrum, by requiring a vertex reconstruction cut as well as another prompt event had preceded the neutron event within a 5ms time window. The application of the AmBe source to the SNO detector has been successful. More detailed information of the source data has been documented and will contribute to the determination of systematics for neutron measurement in SNO.

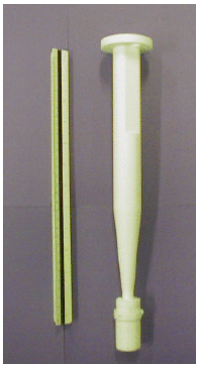

FIG. 1: A picture of the SNO AmBe source. The source is contained in the small cylinder at the lower part of the picture. The rod like structure is the attachment piece to the SNO manipulator source deployment system. Also shown is a ruler for scale.

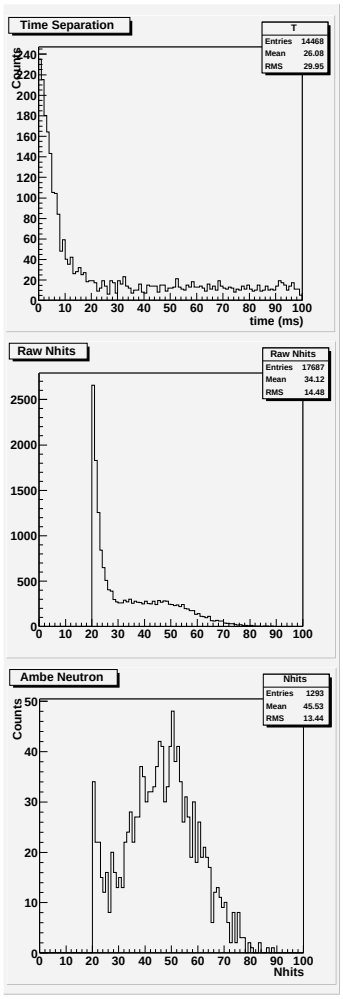

FIG. 2: Raw spectra for the AmBe source when positioned at the center of the SNO detector. Top: Time separation between a prompt and a delayed capture event. Middle: Raw PMT hit spectrum without any cuts. Bottom: Neutron candidate peak from the AmBe source after applying coincidence and position cuts.